EFFECTIVENESS BULLETIN

The prevention and treatment of childhood obesity

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The effectiveness of interventions used in the prevention and treatment of childhood obesity published in a recent issue of *Effective Heath Care* is reviewed.

This article is based on a recent issue of *Effective Health Care* which focused on the effectiveness of interventions used in the prevention and treatment of childhood obesity.[1]

BACKGROUND

Obesity is now considered to be a global epidemic.[2] UK research suggests that the prevalence of overweight and obesity amongst children of all ages is increasing.[3–5] Estimates of actual figures vary due to an ongoing debate as to how best to measure childhood obesity.[6]

There is considerable debate around the reasons for the increasing prevalence of childhood overweight and obesity. Possible explanations include an increase in sedentary lifestyles and changes in dietary patterns and eating habits.[7] Among adults it appears that average recorded energy intake in Britain has declined substantially as obesity rates have escalated, which may suggest that sedentary lifestyles are an important factor.[8 9]

Obesity in childhood can cause dyslipidaemia, hyperinsulinaemia, and hypertension.[10] Additionally, the first obesity related cases of type 2 diabetes in white adolescents have been reported in the UK.[11] Overweight and obesity are also known to have a significant impact on psychological wellbeing with many children developing a negative self-image and experiencing low self-esteem.[12 13]

Halting the rising prevalence of overweight and obesity in children is a public health priority,[14] and there are now a number of government initiatives specifically targeting schools and school children.[15–18] Additionally, guidelines on the weight management of children and adolescents in primary care have been published by the Royal College of Pediatrics and Child Health in conjunction with the National Obesity Forum,[19] and are forthcoming from the Scottish Intercollegiate Guidelines Network.[20]

Based upon updated Cochrane reviews,[21 22] this paper focuses on the effectiveness of interventions in the prevention and treatment of childhood obesity. The Cochrane review on prevention included non-randomised studies, but this paper focuses exclusively on randomised controlled trials (RCTs). Only studies with over 20 participants have been reported in the text, but the results of all 35 included RCTs are reported in tables 1–3.

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School based programmes (table 1)

Health promotion

One school based RCT (n=227) assessed the effects of using a classroom based curriculum to reduce television, videotape, and video game use on changes in physical activity, dietary intake, and obesity (adiposity).[23] At 7 months follow up the children in the intervention group (n=106) were found to watch significantly less television and to play fewer video games than children in the control group. Children in the intervention group also had statistically significant decreases in body mass index (BMI), triceps skinfold thickness, waist circumference, and waist to hip ratio compared with the control group.

Physical activity

In the first RCT (n=310), trained staff encouraged infant school classes (mean age 4.5 years) to take part in a 30 week exercise programme.[24] At the end of the programme there were no statistically significant differences between children who exercised and those in the control group, although the prevalence of obesity decreased in both groups of children.

The second RCT evaluated a physical education programme (project SPARK) designed to provide high levels of exercise for children in three 30 minute sessions per week over an 18 month period.[25] The children in the two exercise groups were led by either specialist PE teachers or classroom teachers. At the end of the programme there were no statistically significant differences in the levels of obesity between those in the exercise group and those in the control group.

Multifaceted interventions

The Active Programme Promoting Lifestyle in schools (APPLES) RCT (n=636) included children aged 7–11 years.[26] The programme consisted of teacher training, modification of school meals, the development of school action plans targeting the curriculum, physical education, tuck shops, and playground activities, and was compared with a no intervention control group. Ten primary schools were randomised and at 1 year there was no difference in change in BMI scores between the two groups. The APPLES programme had little effect on children's eating behaviour other than a modest increase in the consumption of vegetables.

The Kiel Obesity Prevention Study (KOPS) was a primary school based intervention which assessed the additional impact of a family based programme for obese children or normal weight children with obese parents (n=297).[27] This RCT

Table 1 RCTs evaluating school based programmes

Reference	Participants	Intervention, duration	Results	Comments
Health promotion				
Robinson[23] (USA, 1999)	School children (grades 3–4) Mean age: 8.9 years % female: not given	I: An 18-lesson, 6-month classroom curriculum to reduce television, videotape, and videogame use (n=106) C: Usual school curriculum (n=121) Follow up: 7 months	Adjusted change in BMI (kg/m^2) –0.45 (95% CI –0.73 to –0.17, p=0.002) Significantly greater reductions were also observed in the I group in terms of triceps skinfold thickness (p=0.002), waist circumference (p<0.001) and waist-to-hip ratio (p<0.001) Intervention group children watched significantly less television (p<0.001) and played fewer video games (p<0.01) than control group children. The groups did not differ for videotape viewing, daily servings of high fat foods, physical activity levels, or cardiorespiratory fitness	Random allocation: Schools matched on sociodemographic and scholastic variables Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Physical activity				
Sallis[25] (USA, 1993)	School children (grade 4) Mean age: 9.25 years 44% female	Followed the Sports, Play, Active Recreation for Kids (SPARK) intervention, incorporating physical education and self-management into the school curriculum over an 18 month period I1. Intervention led by certified physical education specialists (n=151) I2. Intervention led by classroom teachers (n=200) C: No intervention (n=198) Follow up: 18 months	Results were presented as graphs only. Few significant differences were found between the groups in terms of BMI or triceps/calf skinfolds. However, at follow up, girls in the control group had a statistically lower increase in BMI than the other groups (p<0.01)	Random allocation: Schools stratified by % of ethnic minority students and size Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Mo-suwan[24] (Thailand, 1998)	Kindergarten children Mean age: 4.5 years Sex: I=44% female, C=39% female	I: Kindergarten based physical activity programme conducted by specially trained staff and including a 15 minute walk and a 20 minute aerobic dance session 3 times a week. (n=158 baseline, 147 at end of study) C: no intervention (n=152 baseline, 145 at end of study) Follow up: 29.6 weeks	Prevalence of obesity: Baseline: I=12.2%, C=11.7%; 29.6 weeks: I=8.8%, C=9.7%, p=0.057	Random allocation: Randomisation of classes, stratified by school Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Multifaceted interventions				
Sahota[26] (UK, 2001)	School children (aged 7–11 years) Mean age: I=8.36 years, C=8.42 years Sex: I=49% female, C=41% female	I: Active Programme Promoting Lifestyle in Schools (APPLES). Programme designed to influence diet and physical activity and not simply knowledge. Targeted at the whole school community including parents, teachers and catering staff. The programme consisted of teacher training, modifications of school meals and the development and implementation of school action plans designed to promote healthy eating and physical activity (data collection: n=301 baseline, 292 follow up) C: No intervention (data collection: n=312 baseline, 303 follow up) Follow up: One year	Weighted mean difference in BMI: Overweight children: –0.07 (95% CI –0.22 to 0.08) Obese children: –0.05 (95% CI –0.22 to 0.11) All children: 0 (95% CI –0.1 to 0.1)	Random allocation: Ten schools paired according to size, ethnicity and level of social disadvantage, randomised by coin toss Blinding: Children: Unclear Providers: No Outcome assessors: No
DeWolfe[56] (Canada, 1984)	Adolescent girls at least 5 lbs overweight Mean age: 15.9 yrs	All participants attended an 8-week school based weight control programme, containing physical exercise and behavioural therapy components I1: Monthly follow up with physical measurement, plus reinforcement of behavioural, diet and exercise components of the weight control program (n=4) I2: Monthly follow up with physical measurement (n=6) I3: Annual follow up with physical measurement (n=5) Follow up: One year	% change in excess weight: During programme: I1=–9.6, I2=–9.5, I3=–10.5 During follow up: I1=–26.4, I2=–19.9, I3=+40.6 Overall: I1=–34.1, I2=–24.7, I3=+21.1 Similar results for weight change and percentage weight change. Significance not assessed, due to small number of participants involved.	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Flores[29] (USA, 1995)	School children (aged 10–13 years) Mean age: 12.6 years 54% female	I: Thrice weekly aerobic dance class plus health education in place of regular school physical education programme (n=43) C: Usual physical activity (n=38) Follow up: 12 weeks	For girls: Change in BMI; I=–0.8, C=+0.3, p=<0.05 Change in heart rate (beats per min); I=–10.9, C=–0.2, p<0.01 For boys there were no differences between I and C groups	Random allocation: Randomisation of classrooms Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear

Table 1 continued

Reference	Participants	Intervention, duration	Results	Comments
Gortmaker[28] (USA, 1999)	School children (grades 6–8) Mean age: 11.7 years 48% female	I: School-based interdisciplinary intervention focused on decreasing television viewing, decreasing consumption of high-fat foods, increasing fruit and vegetable consumption and encouraging increases in physical activity (n=641) C: No intervention (n=654) Follow up: 18 months (2 school years)	Change in prevalence of obesity in girls (%): C=+2.2, I=–3.3 Adjusted OR=0.47 (95% CI 0.24 to 0.93, p=0.03) Change in prevalence of obesity in boys (%): C=–2.3, I=–1.5 Adjusted OR=0.85 (95% CI 0.52 to 1.39, p=0.48)	Random allocation: Ten schools matched according to town, size and ethnic composition, randomised using random number table Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Muller[27] (Germany, 2001)	School children Mean age: not given. Age range 5–7 years % female: not given	I: At school, an 8 hour course of nutrition education including "active" breaks given by a skilled nutritionist and a trained teacher. Included the following messages: "eat fruit and vegetables each day", "reduce intake of high fat foods", keep active at least 1 hour each day", "decrease TV consumption to less than 1 hour per day". (Additional family-based intervention plus a structured sports programme were offered to families with overweight or obese children and to families with normal weight children but obese parents) (n=136) C: No intervention (n=161) Follow up: One year	Median BMI (baseline, 1 year): I=15.2, 16.1; C=15.4, 16.3; p=NS Median triceps skinfold (mm) (baseline, 1 year): I=10.9, 11.3; C=10.7, 13.0; p<0.01	Random allocation: method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear

I=intervention; C=control.

examined the combined effects of dietary education and exercise in which both the children and their parents were instructed to eat fruit and vegetables each day, reduce high fat foods, keep active at least 1 hour a day, and decrease television viewing. Control children received no intervention. At 1 year there were no significant differences in mean BMI scores between the two groups.

A large RCT (n=1295) involving the multi-faceted "Planet Health" programme targeted older children (aged 11–13 years).[28] This programme promoted physical activity, modification of dietary intake, and reduction of sedentary behaviours. Control schools received their usual health curricula and physical education classes. After 18 months the prevalence of obesity among girls in the intervention schools was reduced compared with controls (OR 0.47; 95% CI 0.24 to 0.93; p=0.03). In addition, there were fewer obese girls in the intervention group than in the control group (OR 2.16; 95% CI 1.07 to 4.35; p=0.04). The programme significantly reduced television viewing hours for both boys and girls.

A much smaller RCT (n=43) assessed whether a "Dance for Health" programme had a greater impact on increasing aerobic capacity, maintaining or decreasing weight, and improving attitudes towards fitness than usual physical education (n=38).[29] At the end of the programme there was a statistically significant decrease in BMI and change in heart rate for girls in the intervention group compared with those in the control group. There were no statistically significant differences between the groups for boys.

Family based interventions (table 2)

Health promotion

In one RCT (n=55) an obesity prevention programme (which stressed the importance of eating a low fat, low cholesterol diet and increasing activity) was compared with a control group that took part in a general health education programme.[30] At the end of the 12 week study there was a statistically significant difference in favour of the intervention in terms of the percentage of daily calories from fat.

In a second RCT, 26 families with non-obese children who had obese parents were randomised to groups that encouraged fruit and vegetable intake or decreased intake of high fat/high sugar foods.[31] At 1 year follow up there was a significantly greater decrease in percentage overweight in favour of parents in the increased fruit and vegetable group, but no significant between group differences in percentage overweight for children.

A third RCT (n=185) compared two types of intervention (routine general information leaflet versus enhanced information about a specific diet, physical activity, active parental commitment, and food diary) delivered by family paediatricians in primary care (table2).[32] At 1 year follow up, although both intervention groups showed a reduction in percentage overweight from baseline, the reduction was significantly greater in the enhanced information group than in the routine information group.

Physical activity and health promotion

In one RCT (n=53) dietary education was compared with dietary education plus exercise and (for the first s6months only) a waiting list control.[33] At 12 months a statistically significant decrease in terms of percentage overweight from baseline was found for both intervention groups, but there were no differences between the two groups. In a second RCT (n=23) comparing dietary education with dietary education plus exercise, statistically significant decreases in percentage overweight from baseline were observed for both groups.[34] At 6 months (but not 12 months) follow up the dietary education plus exercise group showed a statistically significant greater reduction in percentage overweight than the diet only group.

A third RCT (n=35) compared a callisthenics group, a lifestyle exercise group, and an aerobic exercise programme.[35] All

Table 2 RCTs evaluating the effects of family based interventions

Reference	Participants	Interventions, duration	Results	Comments
Health promotion				
Stolley[30] (USA, 1997)	African American girls (aged 7–12 years) and their mothers Mean age: I=9.9 years, C=10.0 years 62% of the mothers and 19% of the daughters were obese	I: 12 week culturally specific obesity prevention programme, focused on adopting a low fat, low calorie diet and stressing the importance of increased activity (n=32) C: general health programme, focused on communicable disease control, effective communication skills, relaxation techniques, and stress reduction (n=33) Both groups led by either a doctoral clinical psychology student or registered dietitian Follow up: 12 months (only 12 week data reported)	Significant between group differences, with treatment mothers consuming less daily saturated fat (–2.1 oz, p<0.05) and a lower percentage of calories from fat (–7.9%, p<0.001) Weight remained unchanged Differences among treatment and control groups were noted for the daughters' percentage of daily calories from fat (–3.9%, p<0.05)	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Epstein[31] (USA, 2001)	Non-obese children from families with at least one obese parent Mean age: I=8.6 years, C=8.8 years 65% female	Both groups received same 6 months treatment and followed the "traffic light" diet, but targeted different dietary goals. Treatment meetings were facilitated by therapists I: increased fruit and vegetable intake (n=13) C: Decreased intake of high fat/high sugar foods (n=13) Follow up: One year	Percentage of overweight: Parents in the increased fruit and vegetable group showed significantly greater decreases (p<0.05) in percentage of overweight than parents in the decreased high fat/high sugar group, while children showed a stable percentage of overweight over time	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Nova[32] (Italy, 2001)	Obese children (at least 20% above ideal weight, aged 3–12 years) and their parents and family paediatricians Mean age: 8.6 years (both groups) 44% female	I1: Family paediatricians provided children and families with leaflets only containing general information regarding obesity and associate risks, general advice on healthy eating, and an invitation to practise some physical activity (n=113) I2: Family paediatricians provided children and families with information on a specific diet (allowing 1400 calories), detailed guidelines regarding physical activity and active parental commitment, and a food diary with instructions for use (n=72) Follow up: One year	Mean (SD) change in % overweight: 0–6 months: I1 (n=92) =–2.95 (8.47), I2 (n=51) =–8.80 (6.62), p=0.0001 0–12 months: I1(n=80) =–2.92 (10.8), I2 (n=50) =–8.50 (9.72), p=0.002 6–12 months: I1 (n=73) =–0.30 (6.19), I2 (n=45) =–0.64 (8.05), p=0.8	Random allocation: Cluster randomisation by family practitioner Blinding: Children: Unclear Parents: Unclear Outcome assessors: Unclear
Physical activity and health promotion				
Epstein[33] (USA, 1984)	Obese children (aged 8–12 years) and their parents Mean age: not given % female	Intervention groups attended 15 education sessions; 8 weekly sessions, the remaining 7 sessions spread out over 20 weeks I1: Traffic light diet (n (baseline, 6 months)=18, 15) I2: Traffic light diet plus increase in exercise programme (n (baseline, 6 months)=18, 15) C: Waiting list control (n (baseline, 6 months)=17, 14) Follow up: 2, 6 and 12 months	At 6 months, children in the treatment groups were significantly (p<0.01) lighter than children in the control group, who gained weight At 6 and 12 months, treatment groups significantly differed in percentage overweight from baseline (p<0.0001 and p>0.05 respectively), but not between treatments	Random allocation: Stratified by relative weight Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Epstein[35 36] (USA, 1985)	Obese children (aged 8–12 years) and at least one parent Mean age: not given 60% female	I1: Diet plus programmed aerobic exercise (walk, run, cycle or swim) (n=13) I2: Diet plus "lifestyle" exercise programme (not instructed to exercise at a particular intensity) (n=12) I3. Diet plus calisthenic exercise programme (3 times per week) (n=10) 8 weekly sessions of treatment and 10 monthly maintenance sessions. Participants also followed a 1200 kcal/d diet, based on the "traffic light diet" and sessions included behaviour modification Follow up: 12 and 24 months	Percentage overweight: Baseline: I=47.8, I2=48.3, I3=48 12 months: I=31.5, I2=32.2, I3=30.5 24 months: I=41, I3=30.3, I3=40.8 At 24 months, percentage overweight was significantly smaller (p<0.05) in lifestyle group than the aerobic or calisthenic group Change in percentage overweight at 10 years[36]: I1=–19.7; I2=–10.9; I3=+12.2	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Epstein[34] (USA, 1985)	Obese girls (aged 8–12 years) and at least one parent Mean age: not given 100% female	Intensive 8 week treatment programme followed by 10 monthly maintenance sessions. Sessions incorporated diet and nutrition education, exercise education (group 1 only) and behavioural procedures I1: Diet plus aerobic exercise programme (n=not given) I2: Diet without exercise (n=not given) Follow up: 6 and 12 months	Mean percentage overweight: Baseline: I1=48 , I2=48.1; 6 months: I1=20.5 , I2=29.3. Both groups significantly different from baseline (p<0.01). Significant between group difference p<0.05 12 months: I1(n=10) =22.6 , I2 (n=9) =29.4. Both groups significantly different from baseline (p<0.01)	Random allocation: Stratified by age, % overweight and physical work capacity Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Epstein[37] (USA, 1995)	Obese children (aged 8–12 years) and their parents Mean age: 10.1 years 73% female	Comparisons of diet and physical activity reinforcement regimes I1: Reinforcing a reduction in sedentary behaviours (n=not given) I2: Reinforcing an increase in physical activity (n=not given) I3: Reinforcing a reduction in sedentary behaviours and an increase in physical activity (n=not given) All groups received 4 months treatment and followed the "traffic light" diet Follow up: One year	Change in percentage overweight: One year: I1=–18.7, I2=–10.3, I32=–8.7. Significantly larger decrease in intervention than control groups (p<0.05) Change in percentage of body fat: I1=–4.7, I2/I3=–1.3 (p<0.05)	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear

Table 2 continued

Reference	Participants	Interventions, duration	Results	Comments
Johnson[57] (USA, 1997)	Obese children (aged 8–17 years) and their parents Mean age: 11.0 years 72% female	I1: 7 week nutrition and eating habit intervention, followed by 7 week aerobic exercise intervention (n=9) I2: 7 week aerobic exercise intervention followed by 7 week nutrition and eating habit intervention (n=10) C: 14–week education on diet and exercise with instructions for behavioural changes (n=9) Follow up: 9 weeks, 16 weeks and 5 years (n=6 in each group at 5 year follow up)	Mean weight (kg): Week 1: I1=73.2, I2=72.0, C=68.6 Week 9: I1=72.0, I2=73.4, C=68.5 Week 16: I1=70.8, I2=71.0, C=68.9 Change in weight over weeks 1–16 significant for I1 (p<0.01) Change over weeks 9–16 significant for I2 (p<0.01) Mean % of ideal body weight (pretreatment, 5 year follow up): I1=168.8, 137.3 I2=153, 137.8 C=186.5, 175.2 I1 and I2 both significantly lower than C (p<0.01)	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Epstein[38] (USA, 2000)	Obese children (aged 8–12 years)) and at least one parent Mean age: 10.5 years 68% female	I: Increasing physical activity (high dose, n=19 low dose, n=18) C: Decreasing sedentary behaviour (high dose, n=20; low dose, n=19) Both groups received 6 months treatment and followed the "traffic light" diet Follow up: 12 and 24 months	Change in percentage overweight from baseline (mean, SD): 0–6 months: I: low dose=–25.6 (8.1), high dose=–26.4 (10.5) C: low dose=–22.4 (12.6), high dose=–27.4 (10.7) All significant (p<0.01) 0–24 months: I: low dose=–12.4 (13.3), high dose=–13.2 (16.4) C: low dose=–11.6 (21.9), high dose=–14.3 (16.9) All significant (p<0.01)	Random allocation: Families stratified by gender and degree of child and parent obesity Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear

I=intervention; C=control.

groups also received dietary education. At 24 months the percentage overweight for the lifestyle group was significantly smaller than for the callisthenics and aerobic groups. Analysis at 10 year follow up indicated that children in the lifestyle and aerobic exercise groups had achieved a statistically significant greater reduction in the percentage overweight than those in the callisthenics group.[36]

Two RCTs (n=61, n=90) compared the effects of increasing physical activity with decreasing sedentary behaviour.[37 38] Participants in both studies were also given the "traffic light" diet to follow. At 1 year follow up in the first RCT, all groups (increased exercise, decreased sedentary behaviours or both) had lost weight compared with baseline.[37] However, children in the reduced sedentary behaviour group had a statistically significant greater reduction in percentage overweight than the other groups. In the other RCT all groups (high or low increased physical activity, high or low decreased sedentary behaviours) showed significant decreases in percentage overweight at 6 and 24 months compared with baseline.[38] However, the differences between the groups were not statistically significant.

Behaviour modification programmes (table 3)

Parents as agents of change

In one RCT (n=33) overweight children (aged 8–12 years) and their parents were assigned to a multi-component behavioural "weight reduction only" programme, a parent training programme involving the same multi-component weight reduction behavioural treatment preceded by a short course for the parents in child management skills, or a waiting list control.[39] At 1 year follow up, while both intervention groups gained weight, there was a statistically significant increase in percentage overweight in the weight reduction only group compared with the parent training group.

In the SHAPEDOWN programme, parents were instructed on strategies for supporting the weight loss efforts of their children, including altering family dietary and activity patterns and improving parenting and communication skills.[40] At 15 month follow up, participants in the intervention programme (n=37) had statistically significant decreases in relative weight compared with a no-intervention control group (n=29).

Another RCT (n=39) evaluated the effects of targeting obese children and their parents for mastery of diet, exercise, weight loss, and parenting skills over 2 years.[41] A control group was taught general strategies for changing behaviour. At 6 and 12 months follow up, children in the intervention group had a statistically significant relative weight reduction compared with controls. These results were not maintained at 2 years.

The final RCT (n=60) examined the effects of parents taking responsibility for their children's behaviour change compared with the conventional approach in which children were responsible for their own weight loss.[42] At 1 year follow up, children in both groups showed a significant decrease in obesity, although there was a statistically significantly greater reduction in the parent-led intervention group.

Family based behaviour modification programmes

One RCT (n=42) compared three methods of involving (or not involving) mothers (mother-child separately, mother-child together, and child alone) in the treatment of their obese adolescents.[43] The intervention programme consisted of behaviour modification, social support, diet, and exercise. At 1 year follow up, the "mother-Child separately" group had lost significantly more weight and showed greater reductions in percentage overweight than the other two groups which, in turn, did not differ from each other.

A second trial (n=40) compared behavioural treatment groups (parent plus child, child only) with a waiting list control group.[44] Children in both behavioural groups lost weight

Table 3 RCTs evaluating the effects of family based behaviour modification programmes

Reference	Participants	Interventions, duration	Results	Comments
Family based programmes with parents as agents of change				
Epstein[58] (USA, 1985)	Obese girls (aged 5–8 years) Mean age: not given 100% female	I: Diet and exercise information plus information on parent management techniques and social learning principles (n=8) C: Diet and exercise information alone (n=11) Follow up: 12 months	Mean (SD) percentage overweight: Baseline: I=41.9 (13.6), C=39.2 (17.1) 12 months: I=15.6 (15.2), C=28 (16.7), (p<0.05) Mean (SD) BMI: Baseline: I=22.8 (2.6), C=22.7 (3) 12 months: I=19.1 (2.8), C=21.4 (3.3) (p<0.05)	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Israel[39] (USA, 1985)	Overweight children (aged 8–12 years) Mean age: 11 years, 4 months % female: not given	I1: Weight reduction only (WRO); multicomponent behavioural weight reduction programme (n=12) I2: Parent training (PT); as WRO, but preceded by short course for parents in general child management skills (n=12) C: Waiting list control (n=9) Follow up: One year (I1: n=11; I2: n=9)	Mean % overweight: Week 1: I1=53.15, I2=45.88, C=56.02 Week 9: I1=41.49, I2=38.71, C=55.09 Change in % overweight at 9 weeks lower in I1 than I2 group (p<0.025), and lower in I2 than C group (p<0.01) One year: I1=45.53, I2=40.40 Change in % overweight at 1 year increased in I1 group compared with I2 (p<0.001)	Random allocation: Stratified blocks based on child percent overweight and age Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Mellin[40] (USA, 1987)	Obese adolescents (aged 12–18 years) Mean age: 15.6 years 79% female	I: 14 × 90 minute sessions using the materials of the SHAPEDOWN programme (encouraging adolescents to make small sustainable changes in diet, exercise, lifestyle and attitudes) plus two parent sessions (n=37) C: No intervention (n=29) Follow up: 15 months from start of intervention	Mean weight change (kg): 3 months: I=–3.11, C=+0.13 6 months: I=–1.40, C=–1.05 15 months: I=–3.88, C=+1.27 Intervention group displayed overall mean weight loss of 5.15 kg compared with control group Programme participation was also associated with a post-treatment and 1 year follow up reduction in relative weight	Random allocation: Method not described Blinding: Children: No Providers: No Outcome assessors: Unclear
Israel[59] (USA, 1994)	Obese children (aged 8–13 years) Mean age: 10 years 11 months % female: not given	Parents and children met separately for 8 × 90 minutes sessions followed by 9 biweekly sessions for a total of 26 weeks. Treatment consisted of discussions and homework assignments I1: Standard treatment condition (n=18) I2: Enhanced child involvement (n=16) Follow up: 1 and 3 years (I1: n=11; I2 n=9)	Mean percentage overweight: Week 1: I1=45.94, I2=48.10 Week 26: I1=33.43, I2=32.55 1 year: I1=45.15, I2=42.32 3 years: I1=52.30, I2=43.29 Mean percentage over triceps norm: Week 1: I1=131.65, I2=118.43 Week 26: I1=101.3, I2=82.99 1 year: I1=129.83, I2=132.68 No significant between group differences	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Epstein[41] (USA, 1994)	Obese children (aged 8–12 years) and their parents Mean age: 10.2 years 74% female	I: Parents and children targeted and reinforced for mastery of diet, exercise, weight loss and parenting skills (n=17) C: participants taught behaviour change strategies and provided non-contingent reinforcement at a pace yoked to the intervention group (n=22) Intervention given over 26 weekly meetings and 6 monthly meetings Follow up: 2 years	Mean percentage overweight: Baseline: I= 60.6, C=58.8 6 months: I= 30.5, C=38.8 (p<0.05) 12 months: I=34.1, C=42.1 (p<0.05) 24 months: I=45.2, C=48.2 (p<0.3)	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Golan[42] (Israel, 1998)	Obese children (aged 6–11 years) Mean age: 9.2 years 62% female	I: Behavioural modification targeted at parents as agents of change, 14 sessions (n=30) C: Children as agents of change. 30 sessions (n=30) Hour long support and educational sessions were conducted by a clinical dietician Follow up: 6 and 12 months.	Percentage overweight: I: Baseline: 39.6 1 year follow up: 24.9 (p<0.001) C: Baseline: 39.1 1 year follow up: 31.0 (p<0.01) Reduction over 1 year was significantly greater in I group than C group (p<0.03)	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Family based behaviour modification programmes				
Brownell[43] (USA, 1983)	Obese adolescents (aged 12–16 years) and mothers Mean age: not given 79% female	Programme of behaviour modification, nutrition education, exercise instruction and social support I1: Mothers and children met concurrently in separate groups (n (baseline, 16 weeks, 1 year)=14, 13, 12) I2: Children and mothers attended all sessions in the same group (n (baseline, 16 weeks, 1year)=15, 13, 12) I3: Children met in groups, mother did not take part in formal treatment programme (n (baseline, 16 weeks, 1 year)=13, 13, 13) Follow up: One year	Change in % overweight: 16 weeks: I1=–17.1, I2=–7.0, I3=–6.8 1 year: I1=–20.5, I2=–5.5, I3=–6.0 Significant reduction in % overweight for I1 at 16 weeks (p<0.01) and at 1 year (p<0.05) compared with I2 and I3 Mean change in weight (kg): Significant reduction in mean weight (kg) for I1 at 16 weeks (p<0.04) and at 1 year (p<0.01) compared with I2 and I3	Random allocation: Method not described Blinding: Children: No Providers: No Outcome assessors: Unclear

Table 3 continued

Reference	Participants	Interventions, duration	Results	Comments
Kirschenbaum[44] (USA, 1984)	Overweight children (aged 9–13 years) and their parents Mean age: I1=10.4, I2=11.2, C=10.5 77% female	I1: Parent plus child condition. Parents and children attended all sessions together. Emphasis was placed on the importance of parents and children working together (n=13) I2: Child only condition. Only children attended group sessions (n=9) C: Waiting list control condition (n=8) Follow up: 3 and 12 months	Weight reduction index: Parents and children in groups I1 and I2 lost significantly more weight than those in group C at 9 weeks ($p<0.01$), 3 months ($p<0.01$), and at 1 year, although I1 and I2 did not differ significantly from each other at any follow up. Children in group C significantly gained weight at 3 months ($p<0.05$). Similar results were found for percentage overweight	Random allocation: Stratified by gender, age and initial percentage overweight Blinding: Children: Unclear Parents: Unclear Outcome assessors: Unclear
Senediak[45] (Australia, 1985)	Overweight children (aged 6–13 years) and their parents Mean age: 10.3 years % female: not given	I1: Rapid behavioural intervention (n=12) I2: Gradual behavioural intervention (n=12) C1: Non-specific control (n=11) C2: Waiting list control (n=10) Follow up: 26 weeks. I1 (n=8), I2 (n=10), C1 (n=7)	Mean percentage overweight: Week 1: I1=34.63, I2=34.93, C1=41.68, C2=37.64 Week 4: I1=29.37, I2=30.70, C1=40.32, C2=39.95 Week 15: I1=20.99, I2=17.84, C1=36.72, C2=no further contact Week 26: I1=19.94, I2=16.64, C1=30.80, C2=no further contact	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Graves[60] (USA, 1988)	Obese children (aged 6–12 years) and their parents Mean age: 9.3 years % female: not given	Three different treatment protocols for an 8 week weight loss programme I1: Problem solving group (n=not given) I2: Behavioural group (n=not given) I3: Instruction only group (n=not given) Follow up: 3 and 6 months	Children in I1 and I2 groups significantly reduced their body weights, percentages overweight, and BMIs significantly from pre- to post–treatment ($p<0.05$), whereas children in the I3 group did not. These differences were maintained at 3 and 6 month follow up. The I1 group demonstrated significantly greater reductions in percentage overweight and BMI from post treatment to 3 month follow up ($p<0.05$) than I2 and I3 groups	Random allocation: Method not described Blinding: Children: Unclear Providers: No Outcome assessors: Unclear
Wadden[61] (USA, 1990)	Overweight girls (aged 12–16 years) and mothers Mean age: 13.8 years 100% female	All children attended 16 weekly 1 hour treatment sessions following the "weight reduction and pride" (WRAP) programme I1: Child alone (n=19) I2: Mother and child together (n=14) I3: Mother and child separately (n=14) Follow up: 6 months (n=31)	Mean BMI for all participants decreased from 35.2 at baseline to 33.9 at 16 weeks ($p<0.001$). There were no differential changes among treatment conditions Mean BMI for available participants at 6 month follow up was 35.4, which did not significantly vary from baseline	Random allocation: Stratified on the basis of BMI Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Flodmark[46] (Sweden, 1993)	Obese children (aged 10–11 years) and families Mean age: not given 52% female	I1: Family therapy as adjunct to conventional treatment (dietary education by a dietitian, regular visits to a paediatrician, encouraged to exercise) family therapy involved whole family 6 sessions over 12 months (n=24) I2: Conventional treatment (as above) (n=19) C: No intervention (n=50) Follow up: 12 months	BMI, mean (SD): Baseline: I1=24.7 (0.36), I2=25.5 (0.53), C=25.1 (0.35) End of treatment (14–18 months): I1=25.0 (0.53), I2=26.1 (0.72), C=not given 12 month follow up: I1=25.8 (0.73), I2=27.1 (0.88), C=27.9 (0.61) Significantly smaller increase in I1 than in C ($p=0.02$)	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Duffy[47] (Australia, 1993)	Overweight children (aged 7–13 years) and at least one parent Mean age: 9.9 years 79% female	Both groups attended 8 weekly sessions of 90 min duration. Nutritional education was based on Epstein's "traffic light system" I1: Behaviour therapy plus attention placebo control (n=13) I2: Behaviour therapy plus cognitive self management (n=14) Follow up: 3 and 6 months I1: n (3 months, 6months)=10, 8); I2: n (3 months, 6months)=11, 9)	Mean (SD) percentage overweight: I1: Pre-treatment: 51.53 (26.92); post- treatment: 42.43 (25.45) 3 months: 42.84 (24.90) 6 months: 37.09 (21.71) I2: Pre-treatment: 45.48 (17.52) Post-treatment: 37.70 (18.51) 3 months: 38.49 (18.86) 6 months: 37.02 (24.58) Reductions from baseline significant in both groups, but between group differences not significant	Random allocation: Stratified by age group (7–10 years and 10–13 years) Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Braet[48] (Belgium, 1997)	Obese children (aged 7–16 years) and their parents Mean age: not given 63% female	Two randomised behaviour therapy groups including seven 90 min and seven family follow up sessions: I1: Individual therapy (n=48) I2: Group therapy (n=45) Follow up: 12 months	Percentage weight loss from baseline (%): I1: 3 months=5.72; 6 months=8.34; 12 months=9.84; all significant ($p<0.001$) I2: 3 months=3.31; 6 months=8.44; 12 months=13.08; all significant ($p<0.001$)	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear
Epstein[49] (USA, 2000)	Families with at least one child more than 20% overweight Mean age: 10.3 years 52% female	I1: Problem solving taught to parent and child plus standard family based treatment targeting and reinforcing eating and exercise behaviour change (n=17*) I2: Problem solving taught to child plus standard family based treatment (n=18*) I3: Standard family based treatment (n=17*) Follow up: 6, 12 and 24 months *10 drop outs unaccounted for	BMI Z score, mean (SD): Baseline: I1=2.8 (0.9), I2=2.6 (0.9), I3=2.7 (0.8) 6 months: I=1.5 (0.9), I2=1.2 (0.8), I3=1.2 (0.8) 12 months: I1=1.7 (1.0), I2=1.3 (0.9), I3=1.4 (0.9) 24 months: I1=2.3 (1.1), I2=1.7 (0.9), I3=1.6 (1.0) I3 group had larger decrease in mean BMI Z score over 0–24 months ($p<0.02$)	Random allocation: Families stratified by gender and degree of child and parent obesity Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear

Table 3 continued

Reference	Participants	Interventions, duration	Results	Comments
Goldfield[50] (USA, 2001)	Families with obese children (aged 8–12 years) Mean age: I1=9.8 years, I2=10.3 years 71% female	I1: Mixed treatment, whereby participants received a mixture of individualised plus group treatment (n=12) I2: group treatment that did not involve individual therapy (n=12) Follow up: 6 and 12 months	Mean (SD) change in percentage overweight: Baseline–6 months: –9.97 (8.7) Baseline–12 months: –8.04 (10.3) Mean (SD) change in Z-BMI: Baseline–6 months: –0.59 (0.49) Baseline–12 months: –0.64 (0.63) Data for separate groups not given A significant reduction in percentage overweight and Z–BMI was found for both types of intervention over time (p<0.001), though there were no significant differences between interventions. I2 was found to be significantly more cost effective, due to the greater expense of I1	Random allocation: Method not described Blinding: Children: Unclear Providers: No Outcome assessors: Unclear
Programmes with no parental involvement				
Warschburger[51] (Germany, 2001)	Obese children and adolescents (aged 9–19 years) Mean age: I=13.8, C=13.1 % female: not given	Inpatient rehabilitation programme I1. Group which participated in "obesity training" (a three part programme which included a cognitive-behavioural training program, a calorie reduced diet and an exercise program; n=121) I2. Group which undertook the same diet and exercise programmes but received muscle relaxation training instead of the psychological intervention component (n=76) Follow up: 6 and 12 months	Change in mean percentage overweight: 6 weeks: I1=–15.47, I2=–14.03 Both groups significantly reduced their percentage overweight over the course of one year compared with baseline. Differences between the groups were not significant (p values not reported)	Random allocation: Method not described Blinding: Children: Unclear Providers: Unclear Outcome assessors: Unclear

I=intervention; C=controls.

during the intervention and maintained their losses through the 1 year follow up period. No statistically significant differences were found between the behavioural treatment groups.

The third trial (n=45) compared the rapid and gradual scheduling of a behavioural programme with a non-specific control and a waiting list control group.[45] At 6 month follow up the behavioural interventions showed significantly greater reductions in absolute weight loss and percentage overweight than the non-specific control. No statistically significant differences were found between the rapid and gradual scheduling groups.

In another study, 43 children were randomised to receive either conventional treatment or family therapy as an adjunct to conventional treatment.[46] A further 50 non-randomised obese children were included in a control group that received no intervention. At 12 month follow up the BMI scores of all three groups increased, although there was a statistically significant smaller increase in BMI scores in the family therapy group than in the untreated control group. No statistically significant differences were found between the two intervention groups.

In an Australian RCT (n=27), overweight children (aged 7–13 years) and at least one parent were randomly assigned to either behavioural management plus relaxation placebo or a combined behavioural-cognitive self-management approach.[47] At 3 and 6 month follow ups there was a statistically significant reduction in percentage overweight for children in both groups compared with baseline. There were no statistically significant differences between the groups at either 3 or 6 months follow up.

Another RCT compared four different behaviour modification programmes (summer camp training, advice in a single session, group outpatient, individual outpatient) for obese children against a control group.[48] However, the only participants who were randomised were those allocated to the two outpatient programmes (n=93). A statistically significant reduction in mean percentage overweight was found at 6 and 12 months follow up for both outpatient groups compared with baseline. However, there were no statistically significant differences between the two groups.

A 6 month family based behavioural weight control programme (n=67 families) compared parent and child problem solving, child problem solving, and "standard" family based treatment (no problem solving).[49] Over 24 months follow up the "standard" group had a larger decrease in BMI than the parent and child group.

Finally, 31 families with obese children were randomised to receive "mixed" behavioural treatment (a mixture of individualised plus group therapy) or "group" behavioural treatment (that did not involve individual therapy).[50] At 12 months follow up, both treatments produced a statistically significant reduction in percentage overweight and BMI compared with baseline. However, there were no significant differences between the groups.

Behaviour modification with no parental involvement

One RCT (n=197) of a 6 week inpatient rehabilitation programme for children and adolescents compared a three part cognitive-behavioural programme with a programme that provided muscle relaxation training.[51] Both intervention groups received the same diet and exercise programme. In both groups the percentage overweight was significantly reduced over the course of 1 year compared with baseline. Differences between the groups were not statistically significant.

Pharmacological interventions

One RCT examined the effects of metformin on BMI, serum leptin, glucose tolerance, and serum lipids in 29 obese young people aged 12–19 years with fasting hyperinsulinaemia and a family history of type 2 diabetes.[52] At the end of the 6 month

study a statistically significant difference ($p<0.02$) was found between the BMI scores for the intervention group (BMI decreased) compared with the placebo group (BMI increased).

The National Institute of Clinical Excellence (NICE) has approved the use of two drugs, orlistat and sibutramine, in the management of adult obesity.[53 54] However, there is no guidance for the use of these agents in children. An RCT trial of the use of orlistat in obese 12–17 year olds funded by the US National Institute of Child Health and Human Development is currently ongoing.[55]

IMPLICATIONS

There is a lack of good quality evidence on the effectiveness of interventions on which to base national strategies or to inform clinical practice. Trials are often small in size, have high drop out rates, are poorly reported, and crucially involve settings that may be difficult to translate to the UK. Additionally, many of the interventions have been evaluated in only one or two studies and most of the research has been conducted in North America. Many of the studies recruited children either through existing specialist obesity centres or media advertisements. As such, results from these studies may not be applicable to children and their families in other settings.

Future research must be of good methodological quality, involve large numbers of participants in appropriate settings, and needs to be of longer duration and intensity. The cost effectiveness of obesity related prevention and treatment needs to be addressed.

There are now a number of government initiatives specifically highlighting the key role that schools can play in improving the health of children. There is some evidence that multifaceted school based programmes that promote physical activity, the modification of dietary intake, and the targeting of sedentary behaviours may help to reduce obesity in school children, particularly girls.

Multifaceted family based programmes that involve parents, increase physical activity, provide dietary education, and target reductions in sedentary behaviour may help children to lose weight.

There is some evidence that family based behaviour modification programmes, where parents take primary responsibility and act as agents of change, may help children to lose weight.

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